SAXIFRAGA TEMPESTIVA (SAXIFRAGACEAE), A NEW SPECIES FROM THE PACIFIC NORTHWEST

Patrick E. Elvander and Melinda F. Denton
Department of Botany, University of Washington, Seattle 98195

Taxonomic differences in *Saxifraga* have been based largely on plant habit, ovary position, and shape of the filaments, petals, and leaves. Little attention has been given to the nectary disc, although in a comparative study, this character proved to be especially useful in delineating a new species. *Saxifraga tempestiva* (fig. 1) is described as a new taxon from western Montana and is classified in sect. *Boraphila* subsect. *Integrifoliae*. To ascertain the relationships of the new species with its apparent allies in sect. *Boraphila*, a study was made using species in subsect. *Integrifolia* and in the closely related subsect. *Nivali-virginienses*.

Saxifraga tempestiva Elvander & Denton, sp. nov. Perennis, caudice erecto, bulbillis frequenter praedito; scapi 1.5–8.0(–10) cm alti, glabri vel pilis glanduliferis septatis usque ad 1 mm longis et cellulis purpureis terminantibus; folia anguste ad late obovata, 0.5–2.0(–3) cm longa, 0.2–1.5 cm lata, glabra, marginis integris ad minutis dentatis; inflorescentia floribus (1–)3–5(–10) composita, cymosa; bracteae integrae, lineares, 5–8 mm longae; pedicelli 0.5–1.0 mm longi; sepala ovata, 1–2 mm longa, viridia ad atropurpurea, horizontaliter patentia, basi parve connata; petala late elliptica a spatulata, 0.5–1.0 mm longa, alba, unguiculata, breviora quam sepalis; stamina sub anthesi sepalis subaequantia, filamentis 1–2 mm longis, albis; discum nectariorum ovario circumdatum, maculosum, purpureum ad atropurpureum sub anthesi, crassum, succulentum, fere sub fructificatione conspectum; carpella 2(raro 3–4), viridia ad integerrime rubelli-purpurea sub anthesi, basi libera, adaxialia, sed ad discum abaxialem nectariorum conjuncta; ovarium amplium, ¾ inferum sub anthesi, aspectu ½–¾ infero sub fructificatione; styli minuti, sub anthesi erecti, sub fructificatione recurvi; stigmata inconspicua; folliculi rubelli-purpurei, 2–3 mm longi, ex ovario marginibus adaxialibus ad basim stigmatum dehiscentes; semina sphaerica vel ovoidea longitudinaliter rugosa, brunnea, circiter 0.6 mm longa; $n = 5$.

Type: U.S.A., Montana, Deerlodge County, Anaconda Range, 15 mi southwest of Anaconda, ca 0.6 mi west of Storm Lake Pass at Goat Flat (Storm Lake Quadrat, T.4N., R.13W.), 2830 m, flowering and fruiting, 21 Jul 1974, *Elvander 492*. Holotype: WTU.

The specific epithet is derived from the Latin word "tempestivus" meaning early, opportune, or fit; the name seems appropriately applied to one of the first alpine species to appear when the snow recedes and to one which seems well suited to the habitats in which it is found.

Distribution (fig. 2): Bitterroot Mts. and the Anaconda Range in Montana.

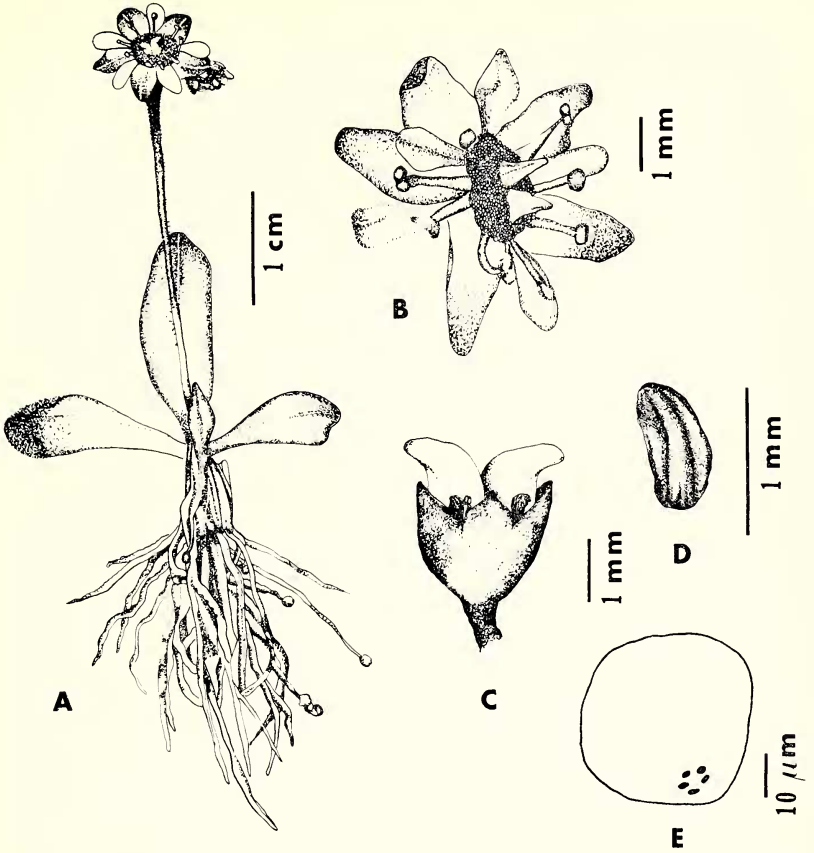

FIG. 1. *Saxifraga tempestiva*. A, habit; B, flower; C, fruit; D, seed; E, camera lucida drawing of pollen mother cell, Metaphase I; A and B drawn by Nancy Williams; C and D drawn by Carolyn Greene; all from *Elvander 440*.

HABITAT: In the Bitterroot Mountains, the plants have been found only on the north-facing slope of East St. Joseph Peak on rocky ledges under *Larix lyallii,* but in the Anacondas, they occur in open, vernally moist depression areas of alpine meadows and slopes where winter snowfall persists until late June, July, or August. The known collections are from elevations of 2400 to 3150 meters.

PHENOLOGY: Flowering specimens have been collected in June and July, and fruiting specimens in July and August.

ADDITIONAL COLLECTIONS: Montana, Deerlodge Co., Anaconda Range, about 15 mi SW of Anaconda, Little Rainbow Mt., *Lackschewitz 4531* (MONTU, WTU); Little Rainbow Mt., about 1 mi E of Storm Lake Pass, *Elvander 489* (WTU); peak of Little Rainbow Mt., ½ mi E of Storm Lake Pass, *Elvander 490* (WTU); 1½ mi toward Storm Lake

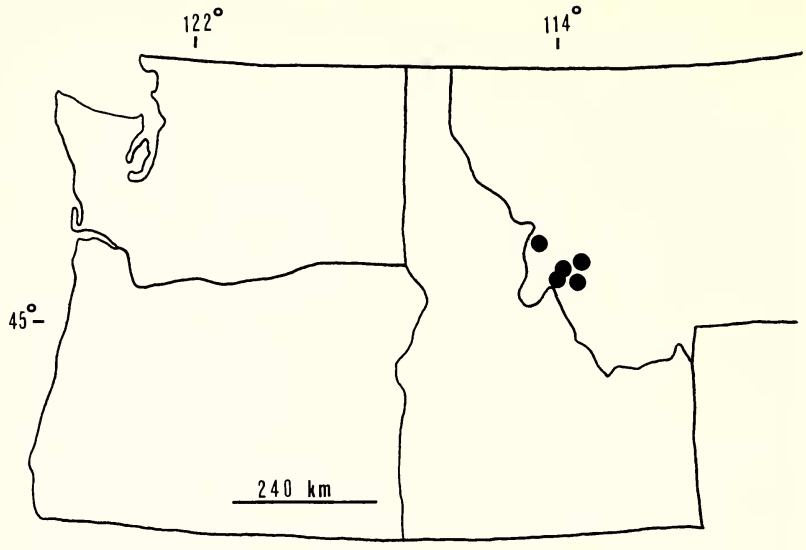

Fig. 2. Distribution of *Saxifraga tempestiva*.

Pass from Storm Lake Dam, *Elvander 438* (WTU); Goat Flat, about two-thirds mi W of Storm Lake Pass, *Elvander 440, 493* (both WTU); north slope of Mt. Tiny above Storm Lake, *Lackschewitz and Elvander 447a* (WTU); Green Mt. above Storm Lake, *Lackschewitz s.n.* (MONTU); Anaconda Range, about 25 mi SW of Phillipsburg above Big Johnson Lake, S side of Pintlar Pass, *Elvander 506* (WTU); slope of the ridge ¼ to ½ mi from Pintlar Pass toward E. Pintlar Peak, *Elvander 507, 508* (both WTU). Ravalli Co., Bitterroot Mts., E. St. Joseph Peak, *Lackschewitz 2122* (MONTU, WTU); about 25 mi S of Missoula, *Elvander 468* (WTU). Granite Co., Anaconda Range, about 25 mi SW of Phillipsburg, above Big Johnson Lake, north slope ledges between Pintlar Pass and E. Pintlar Peak, *Elvander 504* (WTU). Beaverhead Co., Anaconda Range, summit of E. Pintlar Peak, *Hitchcock and Muhlick 12875* (WTU).

Materials and Methods

Field and herbarium studies were conducted with seven closely related taxa of *Saxifraga* (*S. integrifolia* Hook., *S. marshallii* Greene, *S. occidentalis* Wats. var. *occidentalis* and var. *idahoensis* (Piper) Hitchc., *S. oregana* Howell, *S. rhomboidea* Greene, and *S. tempestiva*. Herbarium specimens examined are at MONTU and WTU, and vouchers for cytological preparations are at WTU. Buds for cytological studies were fixed in a solution of absolute ethanol and glacial acetic acid (3:1, v:v). After fixation, this solution was replaced with 70 percent ethanol, and the buds were refrigerated until used. Chromosome counts were obtained using standard acetocarmine squash techniques.

To assist in analysis of morphological data, two computer programs were utilized: a cluster analysis program and a stepwise discriminant analysis program. Twenty-six characters (Table 1) were selected to represent the morphological profiles of each taxon, and these data were used by both programs. Fifteen individuals from each of seven taxa were analyzed. The clustering program, MINFO (Goldstein and Grigal, 1971), uses a mutual information method (Orloci, 1969); all data were scaled to a 0–1 base for equal weighting and the resulting calculations were used to construct a dendrogram reflecting degrees of relationship. Stepwise discriminant analysis (Dixon, 1970) is classificatory and ranks each character according to its usefulness in constructing a classification; the separation of individuals as calculated by this program is graphed in two dimensions using the first two canonical variables. The two programs, because they used the same data in different ways, served as objective and complementary checks of each other.

Discussion

The predominantly inferior ovary and sessile leaves with entire to dentate margins are the main features that serve to place *S. tempestiva* along with *S. oregana* and *S. integrifolia* in sect. *Boraphila* subsect. *Integrifoliae*. The closely related subsect. *Nivali-virginienses* containing *S. occidentalis, S. marshallii,* and *S. rhomboidea,* is distinguished by usually petiolate leaves with serrate to dentate margins and ovaries that are mostly superior. *Saxifraga rhomboidea,* which is intermediate between the two subsections, is presently classified in subsect. *Nivali-virginienses* (Engler and Irmscher, 1916), mostly because this subsection contains more variability than *Integrifoliae*.

One of the most diagnostic features of *S. tempestiva* is a flattened nectary disc (fig. 3, A) that is fused entirely around the carpels and covers

Table 1. Enumeration of Morphological Characters used in both Computer Analyses (MINFO and Stepwise Discriminant Analysis). Rankings of the 12 characters selected and used in Stepwise Discriminant Analysis are indicated parenthetically.

1. Density of hairs on the stem; 2. Petal length; 3. Petal length/petal width; 4. Sepal length; 5. Petal length/sepal length (11); 6. Degree of reflexion of the sepals (2); 7. Petal shape (7); 8. Filament length; 9. Filament shape (12); 10. Pedicel length; 11. Number of flowers per inflorescence; 12. Number of branches from main axis of the inflorescence; 13. Position of the ovary at anthesis (6); 14. Leaf length/leaf width (10); 15. Petiole length; 16. Degree of serration of the leaf margins; 17. Color of gland or disc surrounding the carpels (5); 18. Height of the plant (9); 19. Color of the apical cells on glandular stem hairs (4); 20. Presence/absence of yellow spots on the petals (3); 21. Structure of the nectary gland or disc (1); 22. Degree of lobing of the nectary disc; 23. Extent of emergence of the styles from the nectary disc (8); 24. Density of hairs on the leaf margins; 25. Density of hairs on the abaxial leaf surface; 26. Degree of fusion of the nectary disc around the carpels.

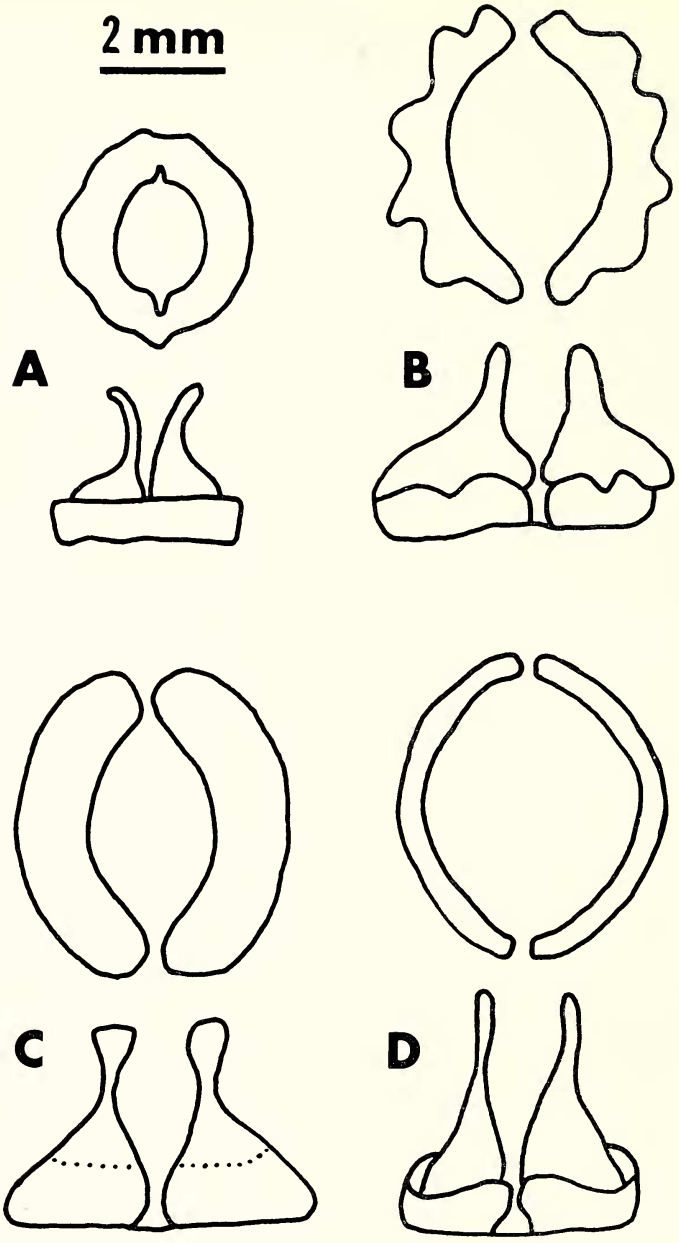

FIG. 3. Top and side views of nectary discs in *Saxifraga*. A, *S. tempestiva;* B, representative of both *S. integrifolia* and *S. oregana*; C, *S. rhomboidea*; D, *S. occidentalis*.

most of the ovuliferous portion of the ovary. The nectary discs in *S. integrifolia, S. oregana,* and *S. rhomboidea* (fig. 3, B and C) are similar to that in *S. tempestiva* because they are flattened and cover most of the ovary, but differ in that the discs are lobed, or divided in two sections, with each lobe covering a carpel. The two bandlike sections of the nectary disc in the *S. occidentalis* complex (including *S. o.* var. *o., S. o.* var. *idahoensis,* and *S. marshallii*) surround, but do not cover, each carpel (fig. 3, D).

Although *S. tempestiva* is morphologically homogeneous, the heterogeneous nature of related taxa results in intergradations that make relationships difficult to assess. Computer-assisted studies have served to clarify the relationships of *S. tempestiva* and to point out some of the taxonomic problems inherent in related taxa. Results of both the cluster analysis (fig. 4) and the discriminant analysis (fig. 5) clearly segregate *S. tempestiva* from related taxa and show agreement with subjective interpretations. In each of the programs, the *S. occidentalis* complex was separated as a group, with *S. rhomboidea* occupying a position intermediate between *S. occidentalis* (subsect. *Nivali-virginienses*) and *S. integrifolia, S. oregana,* and *S. tempestiva* (subsect. *Integrifoliae*). As an indication of the variability known for these species, all but *S. tempestiva* have had varieties and subspecies circumscribed within them (Engler and Irmscher, 1916; Kearney and Peebles, 1951; Hitchcock et al., 1961). The occurrence of apetaly and micropetaly in several of the varieties contributes to the difficulty in their identification. For example, in the results of the cluster analysis (fig. 4), the classification of two morphological forms of *S. integrifolia* is dichotomous rather than parallel; these two forms are described as "varieties *apetala* and *leptopetala*". Those specimens grouped near *S. rhomboidea* are all "var. *apetala*", while those specimens grouped near *S. oregana* are all "var. *leptopetala*". The computer analysis does not recognize a discrete taxon, *S. integrifolia.* The dilemma is biological, not an artifact of the analysis, and recurs in the evaluation of other species (Hitchcock et al., 1961; Krause and Beamish, 1972, 1973; Elvander, 1975).

The meiotic haploid number of five for *S. tempestiva* (fig. 1) provides a new chromosome number for *Saxifraga* as well as for the Saxifragaceae. The low haploid numbers reported for *Saxifraga* are $n = 7, 8, 9, 10, 11, 12, 13, 14,$ and 15, to which 5 can now be added. The haploid number of 6 is not yet reported, but only about 30 percent of the estimated 325 species of *Saxifraga* have been investigated cytologically. Available haploid chromosome numbers for taxa of *Saxifraga* in subsects. *Integrifoliae* and *Nivali-virginienses* occurring in the Pacific Northwest range from 10 to 60 (cited in standard indices). Although numerous aneuploid and polyploid derivatives limit establishment of relationships among taxa on chromosomal evidence, the chromosome number of five may be the original basic number from which the chromosome numbers in *S. rhom-*

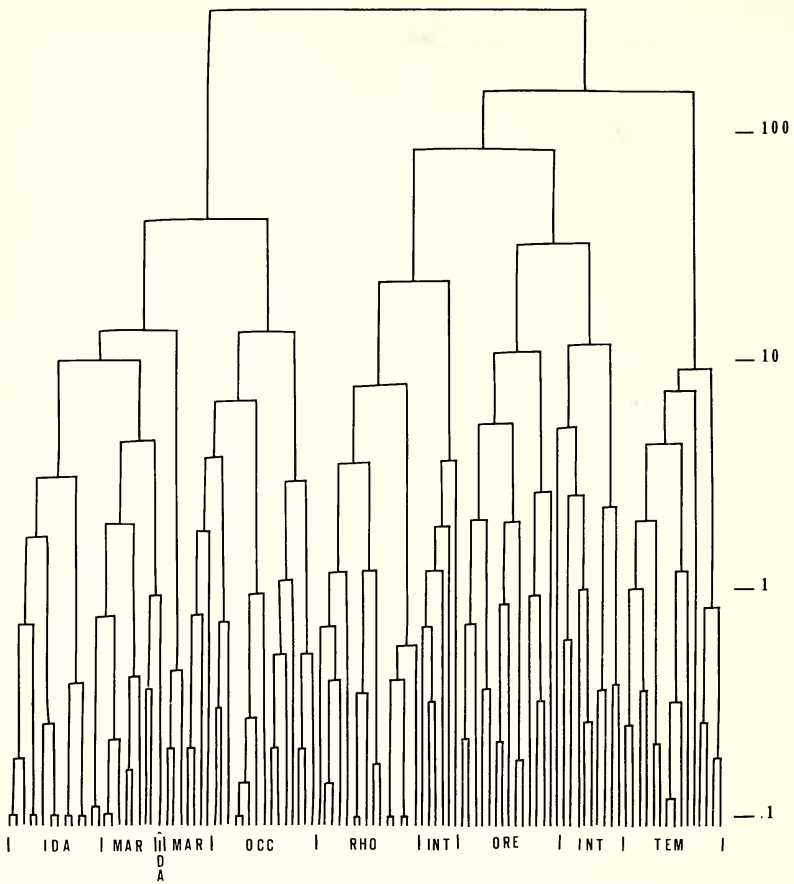

Fig. 4. Dendrogram reflecting degrees of relationship among individuals of each taxon used in the cluster analysis program (MINFO). IDA, *S. occidentalis* var. *idahoensis*; MAR, *S. marshallii*; OCC, *S. occidentalis* var. *o.*; RHO, *S. rhomboidea*; INT, *S. integrifolia*; ORE, *S. oregana*; TEM, *S. tempestiva*. The vertical scale is logarithmic.

boidea, S. occidentalis complex, *S. oregana,* and *S. integrifolia* were derived. *Saxifraga tempestiva* could be a relict species maintaining an ancestral number of five or be a product of reversible tetraploidy (Raven and Thompson, 1964; De Wet, 1971). The well-defined habitat, mostly inferior ovary, and nectary disc of *S. tempestiva* suggest that it is a specialized species and not ancestral to the other species in subsect. *Integrifoliae* or to those in subsect. *Nivali-virginienses.*

Acknowledgments

Support for this research was provided by a grant-in-aid of research from the Society of Sigma Xi to P. Elvander and by the Department of

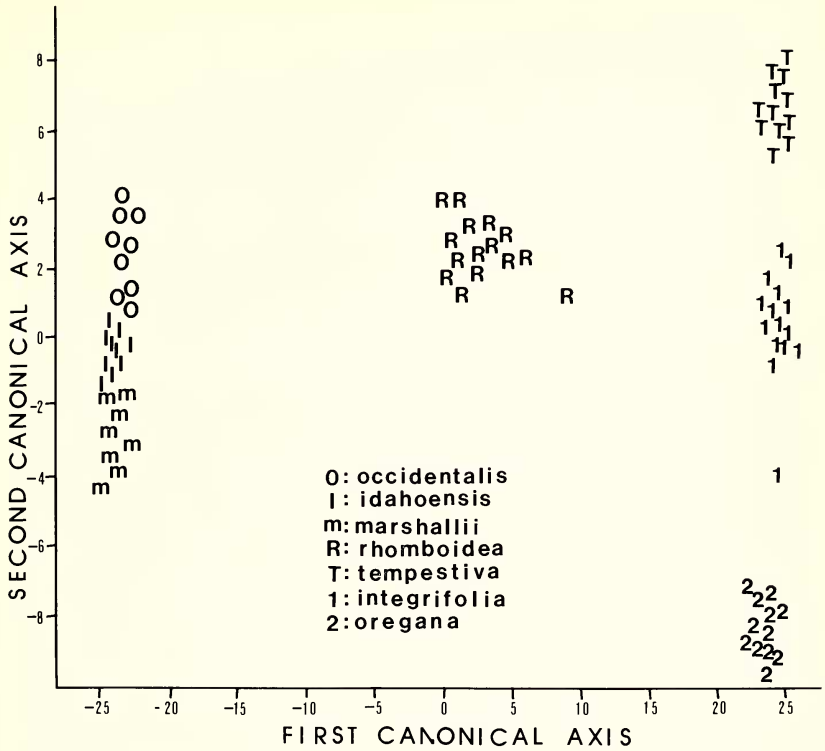

Fig. 5. Distribution of the taxa in canonical space (Stepwise Discriminant Analysis). The first two axes account for 97.4 percent of the variation exhibited by the individuals used in the analysis.

Botany, University of Washington. We are grateful to K. Lackschewitz for field assistance, to D. E. Stuntz for editing our Latin description, and to R. del Moral and A. R. Kruckeberg for their advice during the study.

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A NEW SUBSPECIES OF RHUS CHONDROLOMA (ANACARDIACEAE) FROM MEXICO

David A. Young
Department of Biological Sciences
Union College, Schenectady, New York 12308

During my biosystematic investigation of *Rhus* subg. *Lobadium* (Young, 1975), a new subspecies of *Rhus chondroloma* Standley was discovered. Because the new subspecies and *R. chondroloma* ssp. *chondroloma* are involved in hybrid complexes with *Rhus standleyi* Barkley it is desirable to publish the description of this new taxon before the details of hybridization are presented.

Rhus chondroloma Standley ssp. **huajuapanensis** Young, ssp. nov. (fig. 1). A ssp. *chondroloma* differt: rami et petioli et segmenta rachidis et foliola pubescentes; foliola parviora et numerosiora.

Type: Mexico, Oaxaca, distrito Huajuapan, ca 2 mi N of Huajuapan de Leon, on limestone palm lands along Mex Hwy 190, ca 1620 m, 22 Jan 1974, *S. L. Buchmann and D. A. Young 1–96*. Holotype: RSA; isotypes: MEXU, TEX, UC, US.

Aromatic evergreen shrub or small tree 1–6 m high, with relatively stout, brownish, densely pubescent twigs, dotted with reddish lenticels. Leaves pinnately compound, 3–9 leaflets (most frequently 7), 7.0–10.0 (8.5; numbers in parentheses are the mean for a particular character) cm long; leaflets coriaceous, entire, slightly revolute, margin white-corneous, conspicously pallid-veined, bluish-green above, pale green below; terminal leaflet 2.0–4.0 (3.0) cm long, 1.5–4.0 (2.5) cm wide, distinctly obovate, apex obtuse to rounded (rarely retuse to emarginate), base obtuse; lateral leaflets 2.0–4.0 (3.0) cm long, 1.5–2.5 (1.7) cm wide, elliptic to oval, obtuse at both ends, sessile to subsessile; upper surface of leaflets pilose to puberulous, veins densely pubescent, margins ciliate, lower surface pilose, also densely covered with sessile orange-glandular trichomes. Petioles 1.0–3.0 (1.9) cm long, wingless; rachis segments 1.0–2.5 (1.8) cm long, distinctly winged; petioles and rachis